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<b>Laboratory identification number</b>	LI-B-026-002
<b>Study Report</b>	<b>Testing the bacterial-reduction performance of photodynamic technology against <i>Staphylococcus aureus</i></b>
<b>Test</b>	<p>The validation of the antibacterial activity on a PVC carrier coated with <b>Dr. Schutz VIR-O-BAC Siegel / Sealer</b> using the photodynamic technology.</p> <p>Quantitative determination of the recovered bacterial inoculum according to the following measures:</p> <ol style="list-style-type: none"> <li>1. <math>U_{td}</math>: Dark control (+ additive / – light / + bacteria)</li> <li>2. <math>U_{tl}</math>: Light control (– additive / + light / + bacteria)</li> <li>3. <math>U_t</math>: untreated test specimen (– additive / – light / + bacteria)</li> <li>4. <math>A_t</math>: treated test specimen to determine the antibacterial activity of <b>Dr. Schutz VIR-O-BAC Siegel / Sealer</b> (+ additive / + light / + bacteria)</li> <li>5. <math>U_0</math>: Recovery control</li> </ol>
<b>Sponsor</b>	<p>Dr. Schutz GmbH          Holbeinstr. 17          53174 Bonn</p>
<b>Test method</b>	Quantitative test for the evaluation of bacterial activity on coated surfaces
<b>Active substance</b>	Singlet oxygen generated in situ from ambient air
<b>Interfering substance</b>	Not applicable

<b>Storage conditions</b>	20.0 °C ± 2.5 °C , dry	
<b>Product name</b>	Dr. Schutz VIR-O-BAC Siegel / Sealer	
<b>Test specimen</b>	PVC carrier coated with Dr. Schutz VIR-O-BAC Siegel / Sealer (contains 1.0 % additive), 2 cm x 2 cm 	
<b>Reference material</b>	PVC carrier coated with Dr. Schutz Standard Siegel without additive, 2 cm x 2 cm	
<b>Strain</b>	<b><i>Staphylococcus aureus</i></b> : ATCC 6538; DSM 799	
<b>Contact time</b>	24 h	
<b>Project description</b>	<ul style="list-style-type: none"> <li>• Bacterial contamination of PVC carriers <b>Schutz VIR-O-BAC Siegel / Sealer</b></li> <li>• Microbial reduction via light emitting LEDs in combination with <b>Schutz VIR-O-BAC Siegel / Sealer</b> coated carrier</li> </ul>	
<b>Reference documents</b>	Modification of the following test methods: <ul style="list-style-type: none"> <li>• EN 13697:2019-10</li> <li>• ISO 22196:2011</li> </ul>	
	<ul style="list-style-type: none"> <li>• <b>SOP-ST-MIK.M.0047</b></li> <li>• <b>SOP-ST-MIK.M.0038</b></li> </ul>	
<b>Written</b>	PD Dr. rer. nat. Maren Eggers	
<b>Test facility</b>	Labor Prof. Dr. G. Enders MVZ GbR Abteilung Technische und angewendete Hygiene Rosenbergstraße 85 70193 Stuttgart	
<b>Dates</b>	Delivery date:	2026-02-19
	Begin of testing:	2026-02-19
	End of testing:	2026-02-21
<b>Technical assistance</b>	Niels Fellner	

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## 1. Materials, media and reagents

### 1.1. Abbreviations

%	percentage
°C	Grad Celsius
µL	microliter
A	ampere
A. dest.	Deionized water (type 2)
CFU	Colony forming units
cm <sup>2</sup>	square centimeters
DSM	Deutsche Sammlung von Mikroorganismen
EtOH	ethanol
h	hours
MH agar	Mueller-Hinton agar
min	minutes
mL	milliliter
mm	millimeter
Max.	Maximum
Min.	Minimum
mW	milliwatt
NaCl	sodium chloride
photocat	photocatalyst
R	antibacterial activity
RF	Reduction factor
RT	Room temperature
s	seconds
S. cohnii	Staphylococcus cohnii
SOP	Standard Operating Procedure
V	volt

### 1.2. Apparatus

- Eppendorf pipette variable, 10 µL - 100 µL
- Eppendorf pipette variable, 100 µL - 1000 µL
- Falcon Test Tubes (50 ml)
- fridge 2 - 8°C
- glass pearls
- incubator 36°C ± 2°C
- inoculation loop
- Laminar Air Flow
- McFarland measuring device
- petri dishes in sizes from 90 mm to 100 mm
- pipetting aid (Pipet-Boy)
- pipettes, 5 mL and 10 mL
- stopwatch
- sterile disposable pipettes (1 mL, 5 mL, 10 mL)
- sterile pipette tips (white)
- thermometer
- tweezers
- vortexer
- light source: white light LED, full spectrum 6500K (STWSC12S-E1H10000/4A SunLike LED, manufacturer: Soul Semiconductor)

### 1.3. Materials

- 70% ethanol
- Deionized water (type 2)
- Mueller-Hinton agar
- sodium chloride
- sodium pyruvate
- Tween® 20
- Glycine

### 1.4. Diluent

#### Bacterial suspension

- A. dest.
- 0.1% Tween® 20

#### Test suspension

- NaCl 0,09 g/L
- sodium pyruvate 0.11 g/L

#### Recovery solution

- NaCl 9.0 g/L or 0.9%

## 2. Test methods

The tests were performed according to the modification of the EN 13697:2019-10 and ISO 22196:2019 test methods.

### 2.1. Test strain

To prepare a culture of the test bacteria, *S. aureus* (ATCC 6538; DSM 799) was transferred with a sterile inoculating loop onto TSA plates from the stock culture (incubation at  $36 \pm 2$  °C for 18 to 24 h). From this culture, a sterile inoculating loop was used to transfer bacteria onto fresh Mueller Hinton plates (incubation at  $36 \pm 2$  °C for 18 to 24 h).

## 2.2. Preparation of a standardized test suspension

The colonies of the test bacteria were removed from the Mueller Hinton plates using a sterile inoculation loop. The colonies were and transferred to a tube with glass pearls and deionized water including 0.1 % Tween<sup>®</sup> 20 and vortexed to create a homogenous bacterial suspension. The required microbial density was set to approximately  $10^8$  CFU/ml based on the Mc Farland measurement. To the bacterial test suspension 0.09 g/L sodium chloride and 0.11 g/L sodium pyruvate was added. The suspension was diluted in a ratio of 1:2 with A. dest., so that the test suspension was approximately  $5 \times 10^7$  CFU/mL.

## 2.3. Test procedure

50  $\mu$ l of test suspension was pipetted directly into 10 mL of diluent in order to calculate how much inoculum is recovered ( $U_{t_0}$ ).

The test and control carriers (coated with and without additive) were inoculated with  $5 \times 10^8$   $\mu$ l bacteria. The number of cells was set at approx.  $10^8$  (CFU/mL). They were left to dry in the dark at a temperature of  $36 \pm 2$  °C until visible dry (max. 60 min).

The test was performed in duplicate. Immediately after drying, the carriers for light treatment were placed on the sample tray. Then the irradiation by LED – modules was started according to following settings:

- Intensity: 1000 LUX
- voltage: 23 V
- current: 0.134 A
- contact time: 24 hours

The carriers for the dark control ( $U_{td}$ ) and the reference control ( $U_i$ ) were placed in dark at RT.

Immediately after the contact time, carriers were transferred into a 10 mL diluent. Then the carriers were vortexed for 1 minute. Each sample with a carrier was diluted to  $10^{-5}$  and spread on Mueller Hinton plates. The inoculated Mueller Hinton plates were incubated at  $36 \pm 2$  °C for 24 hours prior to determination of CFU.

## 2.4. Validity controls

### 2.4.1. The logarithmic value of the number of viable bacteria recovered from untreated test specimen immediately after inoculation

The logarithmic value of the number of viable bacteria recovered immediately after inoculation from the untreated test specimens shall satisfy the following requirement:

$$(L_{\max} - L_{\min}) / (L_{\text{mean}}) \leq 0,2 \quad (2)$$

where

$L_{\max}$  is the common logarithm (i.e. base 10 logarithm) of the maximum number of viable bacteria found on a specimen;

$L_{\min}$  is the common logarithm of the minimum number of viable bacteria found on a specimen;

$L_{\text{mean}}$  is the common logarithm of the mean number of viable bacteria found on the specimens.

### 2.4.2. Dark and Light control

To control the influence of the light source on the viable bacterial counts, a specimen without additive ( $U_{tl}$ ) is also exposed to light for the same duration as the treated test specimen. In parallel, the dark control specimens including 1.0 % additive ( $U_{td}$ ) are stored at room temperature in a dark location during the exposure of the treated specimens. These are treated test specimen that have not been exposed to light and therefore have no singlet oxygen release.

### 2.4.3. Internal control (DYPHOX<sup>®</sup> Universal)

For quality management reasons, samples with DYPHOX<sup>®</sup> Universal coating are used as an internal control to determine the antibacterial activity of DYPHOX<sup>®</sup> coated surfaces in a standardized manner using the dry test method.

## 2.5. Calculation

CFU from all plates were counted and only the plates up to 150 colonies were documented. Plates with more than 150 colonies are to be documented with ">150".

If no colonies were recovered in any of the agar plates for a dilution series, then record the number of colonies counted as "< V" (where V is the volume, in mL, in which the carriers are transferred after contact time). For calculating the average when there are no viable bacteria recovered in a dilution series, consider the number of viable bacteria to be "V".

(Example: In the case of V = 10 mL, the number used for calculating the average will be 10.)

The mean bacterial count of reference / light control / dark control / main sample in 1 mL plated volume was determined.

The antibacterial activity is calculated by the following formula

$$R = (U_t - U_0) - (A_t - U_0) = U_t - A_t$$

where

$U_0$  is the average of the common logarithm of the number of viable bacteria, in  $\log_{10}$  CFU/mL, recovered from the untreated test specimens immediately after inoculation;

$U_t$  is the average of the common logarithm of the number of viable bacteria, in  $\log_{10}$  CFU/mL, recovered from the untreated test specimens after contact time;

$A_t$  is the average of the common logarithm of the number of viable bacteria, in  $\log_{10}$  CFU/mL, recovered from the treated test specimens after contact time.

Pass criteria for the mean antibacterial activity according to Table B.2 ISO 22196:2011 shall be  $\geq 1.72 \pm 0.42$ .

### 3. Results and Evaluation

The photodynamic technology in association with PVC carriers coated with **Dr. Schutz VIR-O-BAC Siegel / Sealer** was tested following an exposure time of 24 hour.

#### 3.1. Validity of the test

The recovery control (recovery rate) showed that the test is valid as there were 6 log<sub>10</sub> bacteria in the inoculum (Table 1).

As shown in Table 2, the logarithmic value of the number of viable bacteria recovered immediately after inoculation from the untreated test specimens meets the following requirement of  $\leq 0.2 \log_{10}$  for *Staphylococcus aureus*.

The light control demonstrate a reduction in viable bacteria of 1,44 log<sub>10</sub> compared to the dark control after 24 hours of exposure to white light, respectively (Table 3). Therefore, the assay is valid.

#### 3.2. Test results

The data of the bacterial efficacy data of light emitting LEDs in combination with **Dr. Schutz VIR-O-BAC Siegel / Sealer** coated PVC carrier is presented in Table 4.

The photodynamic inactivation of *Staphylococcus aureus* on PVC carriers by the energy-rich singlet oxygen generated in the test procedure using white light to simulate daylight showed a reduction of 2.85 log<sub>10</sub> (99.86%) in comparison with the controls within 24 hours exposure time.

This is in accordance to the antimicrobial-activity range of  $\geq 1.72 \pm 0.42$  provided in Table B.2 ISO 22196:2011.

12.03.2026

\_\_\_\_\_  
Date



\_\_\_\_\_  
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Head of disinfectant testing and applied / technical hygiene

**Table 1 Recovery rate of test organism**

<i>S. aureus</i>	Contact time	Test 1 log <sub>10</sub> CFU/mL	Test 2 log <sub>10</sub> CFU/mL	Mean	SD
recovery control	24 h	5.95	5.97	5.96	0.01

**Table 2 Test validity according to ISO 22196:2011**

<i>S. aureus</i>	Contact time	Test 1 log <sub>10</sub> CFU/mL	Test 2 log <sub>10</sub> CFU/mL	Mean	SD
L <sub>max</sub>	24 h	3.84	4.05	<b>3.95</b>	0.15
L <sub>min</sub>	24 h	3.89	3.75	<b>3.82</b>	0.10
L <sub>mean</sub>	24 h	3.86	3.98	<b>3.92</b>	0.08
$(L_{\max} - L_{\min}) / L_{\text{mean}} \leq 0.2$	-	-0.01	0.08	<b>0.03</b>	0.11
<b>pass criteria <math>\leq 0.2</math></b>	-	valid	valid	-	-

L<sub>max</sub> is the common logarithm (i.e. base 10 logarithm) of the maximum number of viable bacteria found on a specimen;

L<sub>min</sub> is the common logarithm of the minimum number of viable bacteria found on a specimen;

L<sub>mean</sub> is the common logarithm of the mean number of viable bacteria found on the specimens.

**Table 3 Dark and Light control**

Test organism: *S. aureus*

<i>S. aureus</i>	Contact time	Test 1 log <sub>10</sub> CFU/mL	Test 2 log <sub>10</sub> CFU/mL	Mean	SD	R	Kill rate (%)
U <sub>t</sub>	24 h	3.86	3.93	3.90	0.05	-	-
Dark control	24 h	4.02	4.13	4.08	0.08		
Light control	24 h	2.27	2.57	2.42	0.21	<b>1.44</b>	<b>96.38</b>

**Table 4      Antibacterial activity against *Staphylococcus aureus* on PVC carrier coated with Dr. Schutz VIR-O-BAC Siegel / Sealer, according to ISO 22196:2011**

Test organism: *S. aureus*

<i>S. aureus</i>	Contact time (min)	Test 1 log <sub>10</sub> CFU/mL	Test 2 log <sub>10</sub> CFU/mL	Mean	SD
<b>U<sub>0</sub></b>	<b>24 h</b>	5.95	5.97	5.96	0.01
<b>U<sub>t</sub></b>	24 h	3.86	3.93	3.90	0.05
<b>A<sub>t</sub></b>	24 h	1.40	0.70	1.05	0.49
<b>Reduction</b>	24 h	<b>2.47</b>	<b>3.23</b>	<b>2.85</b>	
<b>Kill rate (%)</b>	24 h	<b>99.66</b>	<b>99.94</b>	<b>99.86</b>	

Test product	Calculation	Mean R	Mean Kill rate (%)
<b>PVC carrier coated with Dr. Schutz VIR-O-BAC Siegel / Sealer</b>	$R = (U_t - U_0) - (A_t - U_0) = U_t - A_t =$	2.85	99.86
	$R = (3.90 - 5.97) - (1.05 - 5.97) = (-2.07) - (-4.92) =$		

Raw data:

**Test 1, *Staphylococcus aureus***

Zeitraum der Prüfung / <i>test period</i> :				2026-02-19 - 2026-02-21			
Produktname / <i>product name</i> :				PVC carrier coated with Dr. Schutz VIR-O-BAC Siegel / Sealer (plus additive)			
Chargenbezeichnung / <i>batch number</i> :				N.A.			
Einwirkzeit / <i>contact time</i> :				24 h			
Produktkonzentration / <i>concentration</i> :				N.A.			
Belastung / <i>interfering substance</i> :				ohne / without			
Prüftemperatur / <i>test temperature</i> :				18°C			
McF:				1,02			
rel. Luftfeuchte / <i>humidity</i> :				43,00%			
Trocknungsbedingungen / <i>drying conditions</i> :				Ohne, feucht mit Deckglas / without, wet covered with cover slide			
Neutralisationsmittel / <i>neutraliser</i> :				N.A.			
Prüfkeim / <i>test strain</i> :				<b><i>Staphylococcus aureus ATCC 6538</i></b>			
Inkubationstemperatur / <i>temperature of incubation</i> :				36.0 °C ± 2.0 °C			
Inkubationszeit / <i>time of incubation</i> :				20 - 48 h			
Product	dilution	cfu (2x100µl)	V <sub>C1</sub> /ml	log10 Na	log10 R	Nts	Validation
<b>Test suspension (N)</b>							
	10 <sup>-1</sup>	150	150	1500	8,68	-	-
	10 <sup>-2</sup>	150	150	1500			
	10 <sup>-3</sup>	150	150	1500			
	10 <sup>-4</sup>	150	150	1500			
	10 <sup>-5</sup>	150	150	1500			
	10 <sup>-6</sup>	49	46	475			
<b>recovery control (U<sub>0</sub>)</b>							
	10 <sup>-1</sup>	150	150	1500	5,95		-
	10 <sup>-2</sup>	150	150	1500			
	10 <sup>-3</sup>	96	81	885			
	10 <sup>-4</sup>	14	14	140			
	10 <sup>-5</sup>	0	1	5			
	10 <sup>-6</sup>	0	0	0			
<b>reference control (U<sub>R</sub>)</b>							
	10 <sup>0</sup>	150	150	1500	3,86	2,08	
	10 <sup>-1</sup>	69	77	730			
	10 <sup>-2</sup>	10	4	70			
	10 <sup>-3</sup>	0	0	0			
	10 <sup>-4</sup>	0	0	0			
	10 <sup>-5</sup>	0	0	0			
<b>dark control (U<sub>td</sub>)</b>							
	10 <sup>0</sup>	150	150	1500	4,02	-0,16	
	10 <sup>-1</sup>	103	108	1055			
	10 <sup>-2</sup>	8	9	85			
	10 <sup>-3</sup>	0	0	0			
	10 <sup>-4</sup>	0	0	0			
	10 <sup>-5</sup>	0	0	0			
<b>light control (A<sub>R</sub>)</b>							
	10 <sup>0</sup>	18	19	185	2,27	1,60	
	10 <sup>-1</sup>	2	3	25			
	10 <sup>-2</sup>	0	0	0			
	10 <sup>-3</sup>	0	0	0			
	10 <sup>-4</sup>	0	0	0			
	10 <sup>-5</sup>	0	0	0			
<b>test sample (A<sub>t</sub>)</b>							
	10 <sup>0</sup>	4	1	25	1,40	2,47	active
	10 <sup>-1</sup>	0	0	0			
	10 <sup>-2</sup>	0	0	0			
	10 <sup>-3</sup>	0	0	0			
	10 <sup>-4</sup>	0	0	0			
	10 <sup>-5</sup>	0	0	0			

**Test 2, Staphylococcus aureus**

Testmethode / test method:					SOP-ST-MIK.M.0047.03		
Zeitraum der Prüfung / test period:					2026-02-19 - 2026-02-21		
Produktname / product name:					PVC carrier coated with Dr. Schutz VIR-O-BAC Siegel / Sealer (plus additive)		
Chargenbezeichnung / batch number:					N.A.		
Einwirkzeit / contact time:					24 h		
Produktkonzentration / concentration:					N.A.		
Belastung / interfering substance:					ohne / without		
Prüftemperatur / test temperature:					18°C		
McF:					1,02		
rel. Luftfeuchte / humidity:					43,00%		
Trocknungsbedingungen / drying conditions:					Ohne, feucht mit Deckglas / without, wet covered with cover slide		
Neutralisationsmittel / neutraliser:					N.A.		
Prüfkeim / test strain:					<b>Staphylococcus aureus ATCC 6538</b>		
Inkubationstemperatur / temperature of incubation:					36.0 °C ± 2.0 °C		
Inkubationszeit / time of incubation:					20 - 48 h		
Product	dilution	cfu (2x100µl)	V <sub>C1</sub> /ml	log10 Na	log10 R	Nts	Validation
<b>Test suspension (N)</b>							
	10 <sup>-1</sup>	150	150	1500	8,68	-	-
	10 <sup>-2</sup>	150	150	1500			
	10 <sup>-3</sup>	150	150	1500			
	10 <sup>-4</sup>	150	150	1500			
	10 <sup>-5</sup>	150	150	1500			
	10 <sup>-6</sup>	49	46	475			
<b>recovery control (U<sub>0</sub>)</b>							
	10 <sup>-1</sup>	150	150	1500	5,97		-
	10 <sup>-2</sup>	150	150	1500			
	10 <sup>-3</sup>	81	106	935			
	10 <sup>-4</sup>	8	6	70			
	10 <sup>-5</sup>	1	3	20			
	10 <sup>-6</sup>	0	0	0			
<b>reference control (U<sub>1</sub>)</b>							
	10 <sup>0</sup>	150	150	1500	3,93	2,04	
	10 <sup>-1</sup>	56	113	845			
	10 <sup>-2</sup>	3	21	120			
	10 <sup>-3</sup>	2	0	10			
	10 <sup>-4</sup>	0	0	0			
	10 <sup>-5</sup>	0	0	0			
<b>dark control (U<sub>id</sub>)</b>							
	10 <sup>0</sup>	150	150	1500	4,13	-0,20	
	10 <sup>-1</sup>	153	115	1340			
	10 <sup>-2</sup>	25	24	245			
	10 <sup>-3</sup>	3	2	25			
	10 <sup>-4</sup>	1	0	5			
	10 <sup>-5</sup>	0	0	0			
<b>light control (A<sub>R</sub>)</b>							
	10 <sup>0</sup>	31	44	375	2,57	1,35	
	10 <sup>-1</sup>	5	12	85			
	10 <sup>-2</sup>	0	1	5			
	10 <sup>-3</sup>	0	0	0			
	10 <sup>-4</sup>	0	0	0			
	10 <sup>-5</sup>	0	0	0			
<b>test sample (A<sub>t</sub>)</b>							
	10 <sup>0</sup>	1	0	5	0,70	3,23	active
	10 <sup>-1</sup>	0	0	0			
	10 <sup>-2</sup>	0	0	0			
	10 <sup>-3</sup>	0	0	0			
	10 <sup>-4</sup>	0	0	0			
	10 <sup>-5</sup>	0	0	0			

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End of Report

Laboratory identification number: LI-B-026-002

**Revision Log**

<b>Version</b>	<b>Date Published</b>	<b>Summary of changes</b>
1	March 12, 2026	Initial test report